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Sinus node modification utilising a novel multi electrode catheter with orthogonal wavefront mapping

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An 18-year-old female with Ehlers Danlos syndrome and severely intrusive symptoms related to inappropriate sinus tachycardia (IST) despite multiple medications had previously undergone 2 sinus node modifications with limited success. The first procedure used cryo-ablation and the second radiofrequency ablation. Despite intra procedural heart rate slowing, patient symptoms recurred soon after the ablation and she was scheduled for a repeat attempt at sinus node modification using a novel multi electrode mapping catheter.

A zero fluoroscopy case was performed using the Precision/NavX system (Abbott, USA). Initial right atrial geometry was initially collected with a TactiCath (F-curve) irrigated 4mm ablation catheter (Abbott, USA). A quadripolar catheter was placed in coronary sinus and a novel 16-polar multi electrode catheter (high density, HD grid, Abbott, USA) used for further geometry collection alongside rapid point collection for simultaneous activation times and a voltage map. A total of 931 points were taken during the map (<5 minutes). Baseline sinus rhythm cycle length was 750 ms. Previous ablation lesions denoted by low voltage were noted in the high right atrium (Fig. 1A). During sinus rhythm the earliest signal

was mapped to the lower superior vena cava (SVC), above the SVC/RA junction and higher than one may have expected (Fig. 1B/C). With incremental doses of intravenous isoprenaline, the earliest activation site became even more cranial and a maximal heart rate of 125bpm was achieved. Ablation (35–40 W) was performed over the sites of earliest activation, with pacing beforehand which ensured no phrenic capture. A short burst of atrial tachycardia occurred during initial ablation which was followed by a change in the P wave morphology at a slightly slower rate (800 ms) suggesting a new, low right atrial rhythm (negative P waves inferiorly, positive in aVL/aVR) (Fig. 2A/B). With low dose isoprenaline, this morphology was maintained with no increase in baseline heart rate. High dose isoprenaline did however reproduce sinus rhythm with upright P waves in the inferior leads but a blunted maximal heart rate response. Further ablation resulted in a junctional rhythm with subsequent recovery of P wave appearance, now with a shortened PR interval of 80 ms, suggesting a possible low atrial septal focus.

Sinus node modification with endocardial ablation alone is difficult to perform with limited success reported in the literature [1,2]. Patient symptoms are often multi factorial and extensive ablation with blunted heart rate response can result in requirement for single chamber (AAI) pacing in the long term which is suboptimal for these patients, many of whom are young [1]. Acute success markers do not often correlate with favourable clinical outcomes.

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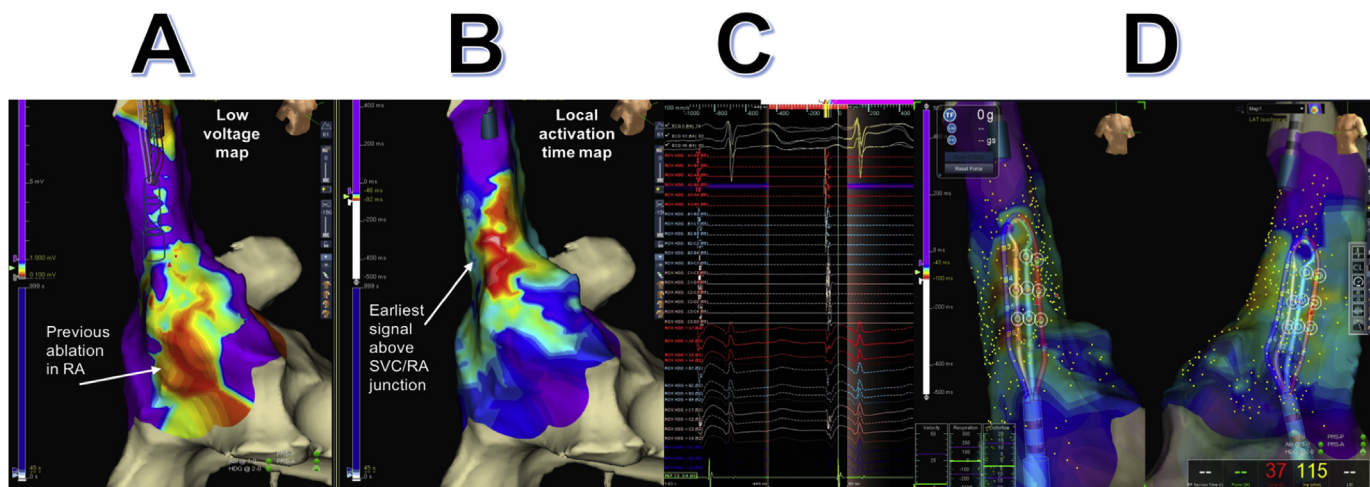


Fig. 1. A: Low voltage electroanatomic map with EnSite Precision (Abbott, USA). Low voltage (0.1mV) depicted in red and healthy tissue (>1mV) purple. Prior ablation in high right atrium (RA). B: Local activation map with earliest signal white/red above the junction of the SVC/RA. Late electrograms shown in blue/purple. C: Electrograms demonstrate QS complexes in selected bipoles from the HD grid. D: HD grid in RA with poles 1–2 superiorly and 17/18 more inferiorly on the shaft of the catheter.

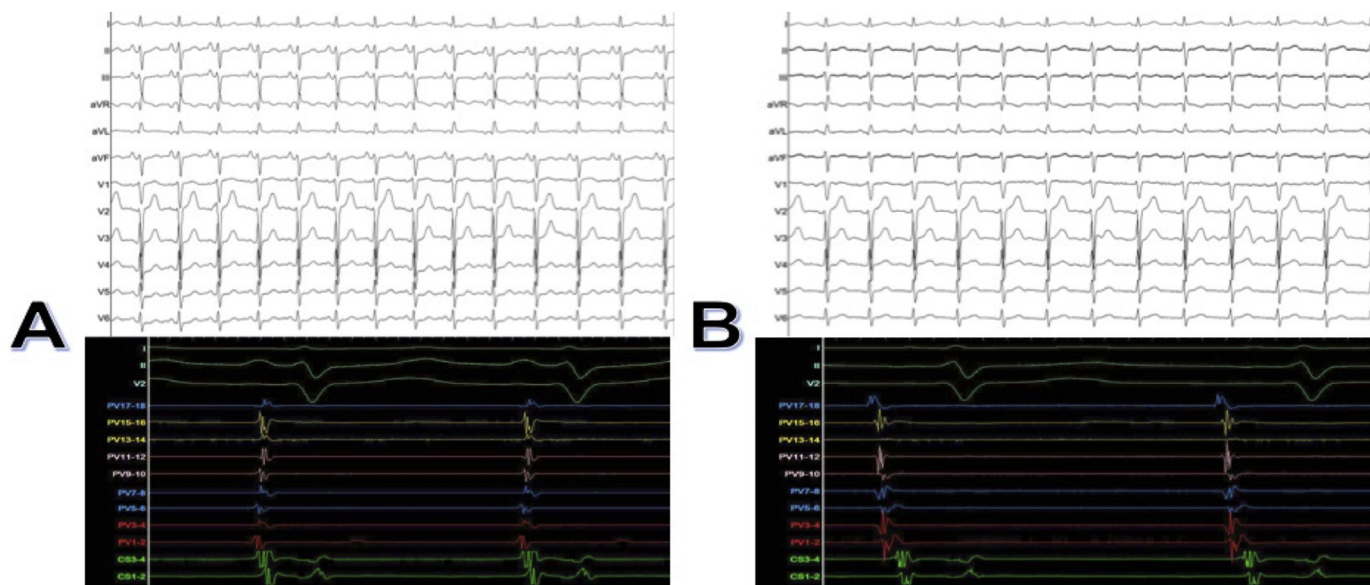


Fig. 2. A: 12 lead ECG of normal sinus rhythm (25mm/s) with corresponding intracardiac electrograms showing poles 1–2 leading. B: During ablation the 12 lead ECG changed demonstrating a new low RA rhythm with negative P waves inferiorly and positive in aVL. The corresponding electrograms now show poles 17/18 leading which were positioned near the floor of the RA.

Isoprenaline is used to mimic the physiological increase in sinus rate seen in IST and incremental doses administered can be quantified, given before and after ablation in order to identify a therapeutic end point. The sinus node does however, have a complex network of neural inputs and chemically acting through beta 1 receptors to increase the heart rate is only one pathway through which heart rate can be increased. Whilst this is a methodical approach used by many for sinus node modification, isoprenaline does not completely mimic the true physiological mechanisms at play and this is a recognized limitation of this technique.

The HD grid multipolar catheter offered several advantages in this case. The shape and handling of the catheter facilitated rapid and accurate anatomical geometry and simultaneous voltage/activation time maps (upto 24 electrograms can be sampled in each given location). There was minimal induction of catheter ectopy and a large number of points were collected in a short time period.

In addition, with the catheter positioned in the vertical axis (A1–D1 in the SVC and poles 17/18 in the RA as shown in Fig. 1D), subtle changes in the site of earliest activation were rapidly identified without having to move the catheter. The HD wave (orthogonal wavefront mapping) algorithm selects the highest amplitude electrogram from two orthogonal bipoles, which reduces directional sensitivity due to the electrical wavefront. The authors suggest this algorithm may have enabled accurate identification of the discrete and different sites of earliest activation during increasing doses of isoprenaline, these sites being only millimetres apart. This is the first reported case of sinus node modification guided by the HD grid and further data is required in order to compare this catheter and algorithm with other multi-electrode catheters.

The patient has since undergone Holter ECG monitor which demonstrated a mean heart rate of 68bpm compared with 108bpm previously. She has had short runs of sinus tachycardia at 130bpm

however, these have been significantly shorter in duration compared with previously.

IST is a complex condition with suggested mechanisms of sinus node over activity (automaticity) and autonomic dysregulation. It is important to distinguish IST from secondary causes such as exogenous substance use, physiological influences (anxiety, pain, dehydration) and medical causes. The long term prognosis of IST is benign and management is difficult in that reducing the heart rate may not alleviate symptoms. Managing patient expectations is important and medical therapy with either Ivabradine (If channel blocker, 1st line) or beta blockers (2nd line) should be considered although they often have limited effect. Sinus node modification with catheter ablation should not be routinely considered for patients with IST however, may be used in those with debilitating symptoms despite medical therapy as was the case in this patient; this is reflected in a class III recommendation in the latest consensus statement [3].

Conflicts of interest

JMB has received speaker fees from Abbott.

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None.

Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.ipej.2018.07.005>

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